

DATA *Nugget*

Fish fights

Featured scientist: Alycia R. Lackey from Michigan State University

Research Background:

In many animals, males fight for territories. Getting a good territory and making sure other males don't steal it is very important! Males use these territories to attract females for mating. The males that get the best territories are more likely to mate with females and have more babies. Only the males that have babies will pass on their genes to the next generation.

Stickleback fish use the shallow bottom areas of lakes to mate. Male stickleback fish fight each other to gain the best territories in this habitat. In their territories, males build a nest out of sand, aquatic plants, and glue they produce from their kidneys. The better the nest, the more females a male can attract. Males then use courtship dances to attract females to their nests. If a female likes a male, she will deposit her eggs in his nest. Then the male will care for those eggs and protect the offspring that hatch.



A male stickleback in his territory (*front*) and an intruding male (*back*)

Alycia is a scientist who is interested in understanding what makes a male stickleback a good fighter and defender of his territory. Perhaps more aggressive males are better at defending their territory and nests because they are better at fighting off other males. She used sticklebacks she collected from British Columbia to test her hypothesis.

In her experiment, 24 males were kept in 6 large tanks, with 4 males in each tank. Alycia watched each of the 24 males every day for 10 days. She recorded the behaviors of each fish when they were competing for territories, defending their territory, and building their nests. She also recorded the size of the males' territories and whether they had a nest each day.

As Alycia observed the fish, she measured three things:

1. Average Male Net Aggression: A number that indicates how many times the fish performed an aggressive behavior, like charging or nipping, minus the number of aggressive behaviors performed by another fish directed at that fish.
2. Average Territory Size: Each fish either had no territory (given the number 0), a small territory (1), or a large territory (2). Their territories changed during the experiment from one day to the next, so scientists averaged the values over the 10 days.
3. Days with Nest: The number of days over the course of the experiment that a fish had a nest.

Check for Understanding: After reading the introduction, students should be able to:

- Describe why males of some species defend their territories. Can students think of animal examples they are familiar with? For example, male dogs mark their territories while they are out on a walk. A lot of bird species will defend their nest sites.
- Discuss other reasons an animal may defend a territory, besides attracting mates. For example, squirrels and some bird species cache food and defend areas from thieves that might steal their food.
- In their own words, describe the experimental design and the data Alycia recorded.

Scientific Question: How does aggressiveness in male sticklebacks affect their ability to defend their territories?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

Scientific Data:

Use the data below to answer the scientific question:

Fish #	Average Male Net Aggression (aggression performed minus aggression received per minute)	Average Territory Size (0: none, 1: small, 2: large)	Days With Nest (number of days with nest)
1	-1.28	0.14	0
2	0.20	0.07	0
3	-0.11	0.29	0
4	-0.47	0.50	0
5	-1.02	0.54	0
6	-1.32	0.00	0
7	0.94	1.14	0
8	-1.18	0.00	0
9	-2.18	0.00	0
10	-0.12	0.36	0
11	1.58	1.00	0
12	-0.24	1.00	0
13	-0.46	0.00	0
14	0.49	1.64	1
15	0.66	2.00	3
16	0.45	1.07	2
17	0.49	1.71	3
18	0.38	1.71	1
19	-0.77	0.44	1
20	1.18	1.93	4
21	-0.11	0.29	1
22	0.85	2.00	3
23	1.35	1.93	3
24	1.09	1.00	3

Check for Understanding: Once your students have had a chance to look over the table, have students discuss in small groups or as a class the following questions: What does a negative Average Male Net Aggression value mean? What can we say about the behavior of fish with negative numbers? What does a positive Average Male Net Aggression mean? What can we say about the behavior of fish with positive numbers?

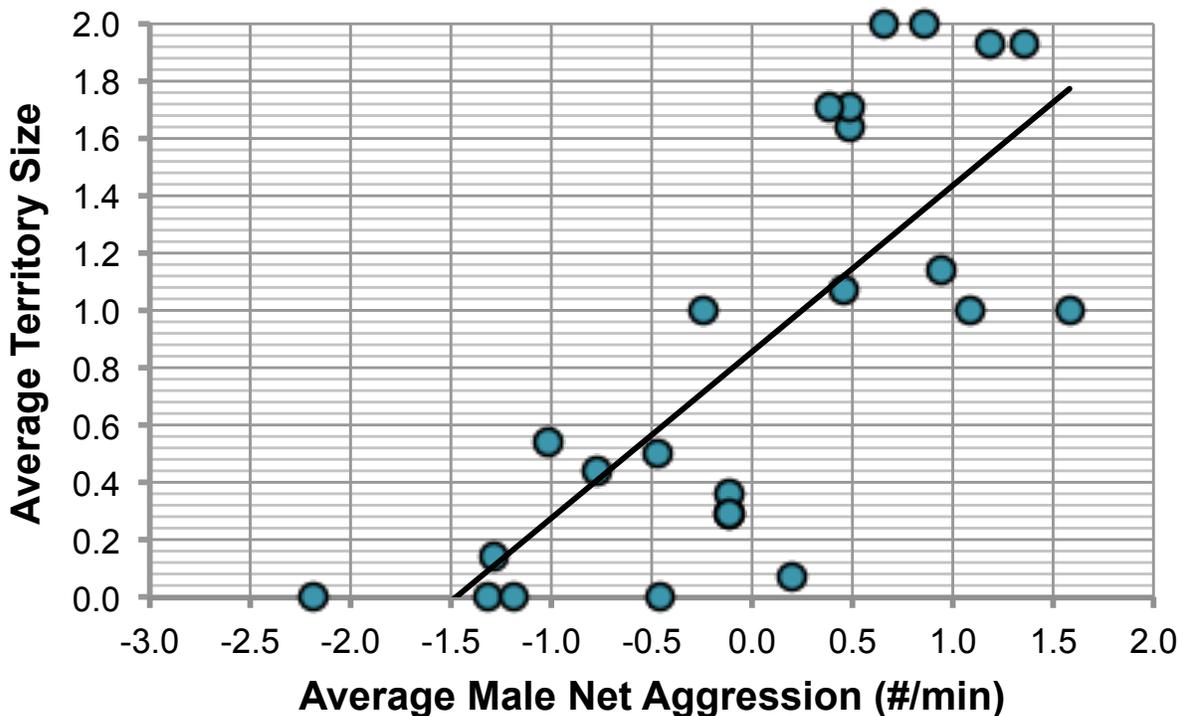
What data will you graph to answer the question?

Independent variable: Average Male Net Aggression

Dependent variable: Average Territory Size

Draw your graph below: Identify any changes, trends, or differences you see in your graph. Draw arrows pointing out what you see, and write one sentence describing what you see next to each arrow.

- There are a lot of males that have low values for territory size.
- Males with higher aggression scores had higher territory size scores.
- The points get higher on the y-axis (average territory size) as you look from left to right.



Teacher Note: To answer the scientific question in this Data Nugget, students should graph the relationship between male aggression and territory size. They will have to select the appropriate data from a table with extra variables that are not needed to answer the question.

The line of best fit is included in the teacher guide but not on the student copies. You can have students add a line of best fit to their graphs to assist in the visualization of the trend. This can be done simply by eye using a ruler to draw a line through the center of the cloud of points. If your students are more familiar with regression lines and associated statistics, they could use Microsoft Excel on a computer to calculate the slope of this line for them, or perform a regression and calculate R^2 and a p-value. However, because the trend in this data is very clear, hand drawing the line should be sufficient.

Interpret the data:

Make a claim that answers the scientific question.

Male fish that act more aggressively towards other males in their tank tend to defend and maintain larger territories over the 10-day experiment.

What evidence was used to write your claim? Reference specific parts of the table or graph.

In the graph with average male territory size versus average male net aggression for the 24 experimental fish, males with aggression greater than 0 tended to have higher territory sizes (between 1 and 2), whereas males with aggression less than 0 tended to have territory sizes less than 1. Advanced: The relationship however, doesn't look linear, because the points seem to fall into two territory size groups, rather than falling along a straight line.

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about the importance of territories for male sticklebacks.

The males that showed more aggression towards other males in their tank had larger territories, on average, over the course of the experiment. This means that the males with larger territories were using aggressive behaviors to keep the other males out of their territory. Maintaining territories is important for mating because males need territories to build their nests in. Females also choose to mate with the males with the best territories and nest. This means that large territories are more likely to attract females. Males that attract more females will have more offspring and pass on their genes to future generations.

Did the data support Alycia’s hypothesis? Use evidence to explain why or why not. If you feel the data was inconclusive, explain why.

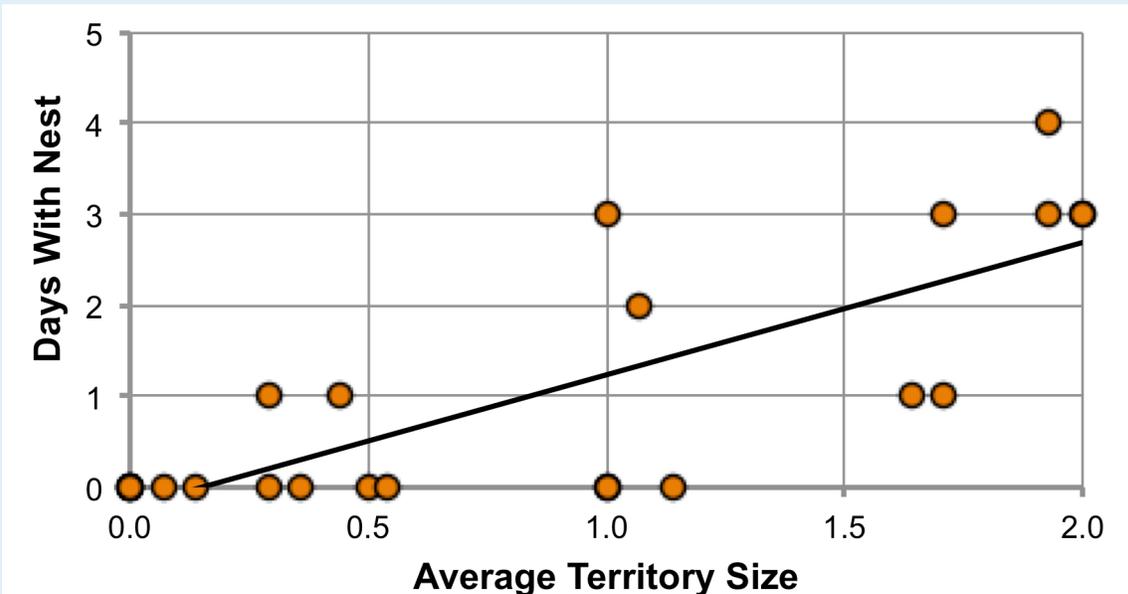
The data supports the hypothesis that aggressive males will be better able to defend against other males from taking away their territory.

Your next step as a scientist: Science is an ongoing process. What new questions do you think should be investigated? What future data should be collected to answer them?

Student responses may vary. See following Teacher Note.

Teacher Note: Student responses may vary, and they will probably generate a wide diversity of questions for in this system. You can have a class discussion where you jot down all the questions up on the board. Be prepared to ask your students to clarify or justify another student's response in a class discussion. Do students see any ways to improve each other's questions? Are some questions untestable? Remember, if your class wants to send their questions about the study system to Alycia, the scientist studying sticklebacks, they can email them to datanuggetsk16@gmail.com!

If you have time, you can have a class discussion using the additional data in the table. One question Alycia was interested in was whether males with big territories are also more likely to have a nest than males with small territories. You can use the “days with nest” column when discussing this question. Ask students to think back to the reason males defend territories (first shared in the Background Information - males need territories in order to build a nest and attract females. In addition, territory size may be important; males that can secure and maintain larger territories may be able to make nests earlier and have nests longer). Though it was not needed to answer the scientific question, have your students think about how territory size relates to whether a male will have a nest or not. Students can predict the relationship between male territory size and their ability to build nests. Students can graph the data to see if there is a positive relationship between territory size and the number of days the males had a nest (see example graph below).



Teacher Note: A few additional ideas for the next steps in this research could be (1) confirming that males who are more aggressive are more likely to have nests, (2) testing whether males who are more aggressive attract more female mates and (3) investigating whether more aggressive males also are better at defending eggs after females have deposited them in the nest, protecting them from predators. (4) It is also important to consider which characteristics females prefer in males. Interestingly, in many animals systems, it is not always the best fighters that make the best mates. Are there other cues that female sticklebacks use to determine which male makes the best mate?

Additional teacher resources related to this Data Nugget:

Alycia's blog post for BEACON on her stickleback work, "Making and Breaking a Species" <http://beacon-center.org/blog/2013/02/04/beacon-researchers-at-work-making-and-breaking-species/>

Alycia's blog post for the MSU museum:
<http://museum.msu.edu/exhibitions/virtual/ssgallerysheets/212.html>



Scientist Alycia out in the field collecting male stickleback fish for her experiments